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# VOCATIONAL GUIDANCE AND THE THEORY OF PROBABILITY

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The pioneer investigators in vocational guidance had ardent hopes of establishing a scientific basis for their operations. So far their hopes have not been realized. An unexpected development has occurred, however, in the rise of vocational *selection*, for although we have not found ways of selecting an occupation for the individual, we have developed methods for the selection of the individual for an occupation with results so encouraging that investigators are inclined to neglect the older field and to minimize the possibilities of it.

Such drastic abandonment of vocational guidance is not necessary. Though the initial enthusiastic dreams may not be realized there is still justification for the belief that methods can be devised which a scientist need not blush to sponsor. One thing is indispensable, however, a thing which has hitherto not been outspokenly noticed: Quantitative statements in vocational guidance must be couched in terms of probability. Only thus can a scientific mode of procedure be developed.

## I. STATEMENT OF VOCATIONAL OPPORTUNITIES IN TERMS OF PROBABILITY

The first phase of vocational guidance in which to apply the theory of probability is that designated "informative." To give information regarding occupations is indisputably recognized as one obligation. This involves the use of statistical records showing rates of pay, seasonal fluctuations, longevity of workers, and the like.

Suppose a young man who is considering the occupation of practising physician inquires what pecuniary rewards he may expect. We have some figures showing the average income of Harvard medical graduates (class of 1906) during the first eight years after graduation which are given in Table I.

TABLE I\*

1st year .....	\$ 502
2nd year .....	826
3rd year .....	1,262
4th year .....	1,765
5th year .....	2,359
6th year .....	2,997
7th year .....	3,650
8th year .....	4,332

\* R. C. CABOT, *Training and Rewards of the Physician*. Philadelphia: J. B. Lippincott Co., 1918. P. 136.

On the basis of these figures we can inform the applicant: "If you have average success you will probably earn during your first year \$502; during your fourth, \$1,765." These figures are illuminating, but consisting, as they do, of mere averages, they are insuffi-

TABLE II\*

Weekly Wages	Number	Percentage
\$3.00 to \$3.99 .....	15	0.2
\$4.00 to \$4.99 .....	121	1.8
\$5.00 to \$5.99 .....	228	3.3
\$6.00 to \$6.99 .....	457	6.7
\$7.00 to \$7.99 .....	621	9.1
\$8.00 to \$8.99 .....	633	9.3
\$9.00 to \$9.99 .....	606	8.9
\$10.00 to \$11.99 .....	1,284	18.8
\$12.00 to \$13.99 .....	1,264	18.3
\$14.00 to \$15.99 .....	1,056	15.4
\$16.00 to \$17.99 .....	362	5.3
\$18.00 to \$19.99 .....	136	2.0
\$20.00 to \$22.49 .....	47	0.7
\$22.50 to \$24.99 .....	4	0.1
\$25.00 to \$27.49 .....	4	0.1
\$27.50 to \$29.99 .....	0	....
\$30.00 and over .....	2	....
Total .....	6,840	100.0

\* "Wages and Regularity of Employment. . . . in the Dress and Waist Industry." *Bulletin of the United States Bureau of Labor Statistics No. 146*. New York. P. 45.

cient. An average may mean several things. With an average of \$502 the lowest sum received may have been \$402 and the highest \$602; or the lowest, \$302 and the highest, \$702. For a true understanding of conditions we must know the entire range of the amounts and their distribution, preferably in percentiles. If the figures were thus presented we should be able to inform the applicant: "If you earn as much as the most prosperous 10 per cent of physicians, you

will probably earn \$702 the first year after graduation, and," say, "\$2,000 the second; if you earn as much as the lowest 10 per cent, you will probably receive \$302 and \$600 for the two years."

A mode of presentation conforming more closely to our requirements is found in the report of a study of the dress and waist industry in New York City. Table II shows the distributed wages paid to 6,840 women workers and the percentages therefor during the year 1913.

On the basis of these figures we can inform a prospective operator: "Your chances of earning \$30 a week are practically zero; of earning \$19, two in a hundred; of earning \$14, twenty-three in a hundred." Such figures can be represented more effectively in a graph similar to the excellent model furnished by Toops and Pintner,<sup>1</sup> showing a boy's chance of becoming an expert tradesman dependent upon education attained.

## II. STATEMENT OF VOCATIONAL APTITUDE IN TERMS OF PROBABILITY

All this information, valuable and reliable though it may be, takes no cognizance of the particular degree of ability which the individual may possess or develop in the direction of the occupation. Accordingly our next task is to bring the specific capacities of the individual into relation with the occupation. Here enter the abused and distrusted vocational tests. It is by their aid that we must calculate the chances of success which an individual will have in a given occupation.

We must take several steps preparatory to this calculation. We must first measure workers in the occupation under consideration with a test or series of tests; secondly, we must express the standings of the workers in a percentile distribution table; thirdly, we must correlate the test-standings with standings in productiveness—expressed in terms of quantity or quality of output, earnings, estimation of overseers—arranged in percentile order; fourthly, we must measure the applicant with the same tests for which we have secured norms from records of workers. Knowing the test-score of the individual under consideration and knowing the chances that an individual standing in one percentile in the tests

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<sup>1</sup> H. A. TOOPS and R. PINTNER, "Educational Differences Among Tradesmen," *Journal of Applied Psychology*, III (March, 1919), 33-49.

will stand in the corresponding percentile on a scale of occupational success, we shall be able to state in terms of probability the chances that the individual will stand in a given position in the occupation, *so far as his ability is concerned*.

Before proceeding farther, let us digress long enough to note that these steps are no different from those taken by the best investigators in vocational selection. They secure a norm, though it must be confessed that there is a lamentable diversity of practice. Some use the scores made by the average of "good" or "satisfactory" workers; some use the average made by the entire group containing both "good" and "poor"; some use the score which just surpasses a "point of reference"<sup>1</sup> or a "critical score."<sup>2</sup> In the interests of uniformity the writer suggests the use of scores made by all members of the group tested, membership in the occupation being defined as ability to hold a job in it. A further recommendation that will surely not be repugnant to a scrupulous investigator is that scores be arranged in percentile distribution. The necessity for this will appear in one of our later hypothetical cases of vocational counseling.

In carrying over into vocational guidance the best methods employed in vocational selection, the principal change we need make is in point of view; whereas the latter regards test data merely in the light of their utility to the employer, the former considers them in the light of their utility to the individual. And they will be serviceable to him only if expressed in terms of probability.

It is also pertinent at this juncture to point out that no plea is being made here for a policy of absolute prognosis, nor for unequivocal advice of any sort. The writer repudiated such an ideal several years ago and proposed a "monitory" conception.<sup>3</sup> The present views aim to extend that formulation and to define more clearly the form which the "admonitions" will take—to state, in fine, that they will come in terms of probability.

In continuing the discussion let us examine the procedure in an analogous field where the theory of probability has had time-

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<sup>1</sup> H. C. LINK, *Employment Psychology*. New York: Macmillan Co., 1919. P. 400.

<sup>2</sup> L. L. THURSTONE, "Mental Tests for College Entrance," *Journal of Educational Psychology*, X (March, 1919), 134 ff.

<sup>3</sup> H. D. KITSON, "Suggestions Toward a Tenable Theory of Vocational Guidance," *Readings in Vocational Guidance*. Edited by Bloomfield. Boston: Ginn & Co., 1915. Pp. 103-8.

honored and successful application—the insurance business. A man of thirty years inquires of an insurance company if he will live to the age of seventy. Actuarians have studied thousands of cases and have discovered that out of every thousand men who are sound at thirty, a fairly constant number, say nine hundred, become septuagenarians. The company physician tests this man and finds him sound. But it does not tell him: “Yes, you will live to the age of seventy.” For although nine hundred in every thousand thirty-year-old sound men achieve the septuagenary, this man may be one of the one hundred to die at an earlier age. Accordingly the physician states the man’s longevity in terms of probability saying: “You have nine chances in ten of living to the age of seventy.” And to show the strength of its conviction the company is willing to wager a specified sum with the applicant.

If we are to have a reliable system of vocational guidance we must employ a similar method. After taking the four steps outlined above we may indicate where an individual will stand in a given occupation according to his measured ability. The degree of reliability attached to our statement will, of course, depend upon the degree of correlation existing between the test-scores and the standings in the occupational “success-scale.” But this amount cannot be adequately expressed by a mere coefficient of correlation. Rather a probability table should be prepared showing the chances that one who stands at a given percentile in the test records will stand at a given percentile in occupational success.

Such a table is Table III,<sup>1</sup> prepared from Thurstone’s<sup>2</sup> scatter-diagram picturing the distribution of 165 persons in a rhythm test and in speed of receiving telegraphic words. The 165 cases were arranged approximately in quintiles with respect to both abilities. (Finer divisions are preferable but require a larger number of cases.) The distribution of these 165 cases was then transformed into a percentile distribution table, 100 hypothetical cases being placed in each of the five vertical and 100 in each of the five horizontal divisions. For example, the thirty-three cases in the first

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<sup>1</sup> For the form of this table the writer is indebted to Dr. S. L. Pressey who has already shown the importance of the theory of probability in the prognostication of academic success and failure in his article, “Suggestions with Regard to Professor Thurstone’s ‘Method of Critical Score,’” *Journal of Educational Psychology*, December, 1919.

<sup>2</sup> L. L. THURSTONE, “Mental Tests for Prospective Telegraphers,” *Journal of Applied Psychology*, III (June, 1919), 110–17.

quintile of test-scores fell in the quintiles of telegraphic success as follows: first quintile, 20; second, 5; third, 4; fourth, 4; fifth, 0. These frequencies transformed into percentages are the figures in the first vertical column of Table III. (Twenty is 60 per cent of 33; 5 is roughly 14 per cent of 33.) The percentages in this illustration should not be considered too binding, for a slight shifting about of the frequency values was occasioned in the effort to place in all the quintiles the same number of cases horizontally and vertically. With these qualifications, the figure at any step of the table represents the number of cases in a hundred that would fall at a particular step.

TABLE III  
PROBABILITY TABLE SHOWING CORRELATION BETWEEN SUCCESS IN  
RHYTHM TEST AND IN RECEIVING TELEGRAPHIC WORDS

TEST-SCORES	OCCUPATION-SCORES				
Division by Quintiles	Division by Quintiles				
	1	2	3	4	5
1.....	60	22	18	0	0
2.....	14	29	30	14	13
3.....	13	27	30	23	7
4.....	13	8	10	30	39
5.....	0	14	12	33	41

Concerning an applicant who stands among the best 20 per cent in the test we can say that there are 60 chances in 100 that he will stand among the best 20 per cent in receiving telegraphic words; there are zero chances that he will stand among the poorest 20 per cent. One who stands among the poorest 20 per cent in the test has zero chances of standing among the speediest 20 per cent of operators, and has 41 chances in 100 of standing among the 20 slowest.

We repeat that the reliability with which we can estimate occupational ability from such a table depends upon the fidelity with which our norms represent a true sampling of abilities. Furthermore, conditions in actual life would present complications involving other abilities and determinants of success—volitional traits such as industriousness; emotional factors such as interest; physiological, such as ocular ability. If it were not for unduly extending the length of this paper we might illustrate the applica-

tion of the theory of probability in the latter field by a hypothetical prognosis of earning capacity based upon an examination of the eye. The condition of this organ is of supreme importance in such occupations as typesetting, watchmaking, and engraving. After measuring the visual capacities—acuties of both eyes, size of the visual field, range and strength of muscular action—of an individual, we might calculate his probable earning ability in a given occupation by applying the formula of Magnus<sup>1</sup> to our measures, a mere matter of solving a simple algebraic equation.

#### SUMMARY

Space forbids further illustration of our thesis. To summarize the argument we repeat that the use of scientific methods in vocational guidance is a realizable thing. It does not require a radical departure from the approved methods of vocational selection. It requires only a shift of emphasis from the needs of the employer to those of the individual, and the presentation of quantities in terms of probability. To facilitate the calculation of probability tables, mass measurements should be presented in entirety and distributed as to frequency in percentiles.

The time for such refinements need not be pushed to the distant future. Much material for use in vocational guidance is already available. The publications of the United States Bureau of Labor Statistics contain voluminous compilations—physical measurements, wage scales, occupational risks. A considerable body of test literature is also arising which, with adaptation according to the foregoing suggestions, can illumine the way. In short, wherever are found occupational figures, there can be found scope for the administration of vocational guidance in terms of probability.

The objection is urged by some that in stating the future in terms of equivocal chance we do not give much assistance to a puzzled youth who seeks to direct his energies along most profitable channels. Humans habitually yearn to foresee the future. They are prone to regard vocational guidance as a sort of Delphic shrine. This quest for certainty must be supplanted by a search for probability and a recognition of the limitations of human knowledge. Moreover, the public must accept the fact that no person and no

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<sup>1</sup> G. M. KOBER, and W. C. HANSON. [Ed.] *Diseases of Occupational and Vocational Hygiene*. Philadelphia: P. Blakiston's Son & Co., 1916. P. 329.

social machinery can exempt the individual from making his own decisions. A vocational counselor can help; can point out opportunities and show their relation to the capacities of the individual, but if he is truthful—scientific—he will state such relationships in terms of probability only. The individual must make his own choice. All the forces on earth cannot relieve him of the responsibility.

This is an arduous unromantic procedure—this application of the arid theory of probability. Nevertheless it is fraught with incalculable benefits to the individual worker, the employer and the great society—surely a goal sufficiently inspiring to call forth the most assiduous scientific endeavors.